Title of the Research :

NUMERICAL STUDY OF HEAT AND MASS TRANSFER IN AN ENCLOSURE WITH CURVED WALL

Submitted by :

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SYNOPSIS

Natural convection is a mechanism or type of heat transport in which the fluid motion is generated by density differences in the fluid occurring due to temperature gradients. The fluid surrounding a heat source receives heat, becomes less dense and rises. Natural convection due to thermal buoyancy effects occurs in various applications of science and technology. Recent interest in convective heat transfer has been mainly motivated by their importance for many natural and industrial problems, especially those associated with mass transfer problems, dead end reverse osmosis, catalytic and electrochemical reactor design, molten material processing, extraction of oils and lipids from vegetable substrates, phase change energy storage process, centrifugal separation and oxidation of carbon particles in supercritical water.

In the field of computational fluid dynamics (CFD) one has to understand the physical events that occur in the flow of fluids around and within designated objects. These events are related to the action and interaction of phenomena such as dissipation, diffusion, convection, boundary layers and turbulence. All of these phenomena are governed by continuity (conservation of mass), momentum (conservation of momentum), and energy equations (conservation of energy).

The studies on natural convection heat transfer in triangular, trapezoidal, parallelogramic enclosures and enclosures with curved and wavy walls filled with fluid, porous and nanofluid media were performed subjected to different thermal boundary conditions. In addition the researchers have also studied the effect of the various parameters such as Rayleigh number, Prandtl number, Darcy number etc. It is found that the study of heat transfer characteristics in complex geometries is essential in order to obtain the design of the container for various industrial applications. Hyun and Choi [1] studied the transient natural convective heat transfer in a parallelogram shaped enclosure at large Rayleigh numbers using the finite difference method. Kent [2] carried out the studies on laminar natural convection in an enclosure of isosceles triangular cross-section with the cold base and hot inclined walls for different angles and various Rayleigh number. The investigation on the fluid and heat flow patterns in the presence of natural convection in trapezoidal enclosure with various thermal boundary conditions has been extensively performed by Basak and coworkers [3,4]. Dalal and Das [5] presented the effect of the non-uniform heating of the bottom wall on natural convection in a two dimensional cavity with a wavy right vertical wall. Mahmud and Islam [6] carried out laminar natural convection and entropy generation inside an inclined wavy enclosure. Adjlout et al. [7] studied the effect of a hot wavy wall due to laminar natural convection in a differentially heated square cavity for different undulations. Investigations dealing with convection problems inside complicated geometries are limited because of complexity of flow inside enclosure which significantly affects the thermal behaviour of the fluid inside it.

The objective of our research is to analyze the heat and mass transfer within an enclosure with curved wall and various heating pattern of walls. Numerical investigation on heating characteristics within enclosure will be carried out based on coupled partial differential equation of momentum and energy which will be solved to obtain the numerical simulations in terms of stream function, heat function, isotherms, heatlines, massline and entropy generation. We will use an approach by means of coordinate transformation which can convert a complicated nonorthogonal or orthogonal nonuniform grid into a simple, uniform orthogonal grid that leads to nonsymmetric matrices. The transformed version of the governing equations is then solved in the computational plane by Biconjugate gradient stabilized method (BiCGStab) to obtain numerical solution of the fluid flow problem.

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